Certifying Industrial Energy Efficiency Performance: Aligning Management, Measurement, and Practice to Create Market Value

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ABSTRACT

More than fifteen years after the launch of programs in the U.K. and U.S., industry still offers one of the largest opportunities for energy savings worldwide. The International Energy Agency (IEA) estimates the savings potential from cost-optimization of industrial motor-driven systems alone at 7% of global electricity use. The U.S. Department of Energy (USDOE) Industrial Technologies Program estimates 7% savings potential in total US industrial energy use through the application of proven best practice. Simple paybacks for these types of projects are frequently two years or less. The technology required to achieve these savings is widely available; the technical skills required to identify energy saving opportunities are known and transferable. Although programs like USDOE's BestPractices have been highly successful, most plants, as supported by 2002 MECS data, remain either unaware or unmotivated to improve their energy efficiency- as evidenced by the 98% of US industrial facilities reporting to MECS say that they lack a full-time energy manager.

With the renewed interest in energy efficiency worldwide and the emergence of carbon trading and new financial instruments such as white certificates[1], there is a need to introduce greater transparency into the way that industrial facilities identify, develop, and document energy efficiency projects. Historically, industrial energy efficiency projects have been developed by plant engineers, frequently with assistance from consultants and/or suppliers with highly specialized technical skills. Under this scenario, implementation of energy efficiency improvements is dependent on individuals. These individuals typically include "champions" within an industrial facility or corporation, working in cooperation with consultants or suppliers who have substantial knowledge based on years of experience. This approach is not easily understood by others without this specialized technical knowledge, penetrates the market fairly slowly, and has no assurance of persistence, since champions may leave the company or be re-assigned after project completion.

This paper presents an alternate scenario that builds on the body of expert knowledge concerning energy management best practices and the experience of industrial champions to engage industry in continuous energy efficiency improvement at the facility rather than the individual level. Under this scenario, standardized methodologies for applying and validating energy management best practices in industrial facilities will be developed through a consensus process involving both plant personnel and specialized consultants and suppliers. The resulting protocols will describe a process or framework for conducting an energy savings assessment and

[1] This concept is being tested in the EU as part of a trading system for energy-efficiency measures and resulting energy savings. The savings are verified by the regulator and certified by means of "white" certificates.

verifying the results that will be transparent to policymakers, managers, and the financial community, and validated by a third-party organization. Additionally, a global dialogue is being initiated by the United Nations Industrial Development Organization (UNIDO) concerning the development of an international industrial energy management standard that would be ISO-compatible. The proposed scenario will combine the resulting standard with the best practice protocols for specific energy systems (ie., steam, process heating, compressed air, pumping systems, etc.) to form the foundation of a third party, performance-based certification program for the overall industrial facility that is compatible with existing management systems, including ISO 9001:2000, 14001:2004 and 6 Sigma. The long term goal of this voluntary, industry-designed certification program is to develop a transparent, globally accepted system for validating energy efficiency projects and management practices. This system would create a verified record of energy savings with potential market value that could be recognized among sectors and countries.

Why do large energy efficiency opportunities remain in the industrial sector?

Industrial firms operate in an environment in which maximizing shareholder value is a governing principle. For manufacturing firms, this means that companies which maximize production for the least possible cost are generally more successful than firms that do not. Managers operating in this environment are always seeking ways to reduce the costs of everything required to support production, including: materials, labor, processing, packaging, and shipping. The cost of purchasing the energy needed for production is viewed as managed input and typically receives significant attention, while the use of that energy once it is inside the factory fence, is often viewed as simply the "cost of doing business". While this is not true in all industrial facilities, experience has shown that unless the facility actively manages energy use and has a written plan for doing so, these facilities are significantly less energy efficient than they could be. Opportunities for energy efficiency improvements exist in most plants and their regular occurrence is well-documented, particularly for industrial systems, such as motor-driven (compressed air, fan, pump, motor/drive), steam, and process heating systems. Here are a few examples of how even sophisticated, well-run companies can realize benefits from actively managing their energy use:

3M, through its Global Energy Management Program, has reduced its energy consumption per net sales by 30% since 2000 and is seeking an overall reduction of more than 40% from 2000 levels by the end of 2008.[2]

Continental Tire worked with energy consultants and in-house management to help a plant in Illinois reduce its energy consumption per tire produced by 31%. [3]

Dow Chemical achieved 22% improvement ($4B savings) between 1994 and 2005 through its corporate energy management system and is now seeking another 25% from 2005 to 2015[4]

United Technologies Corp reduced global GHG emissions by 46% per dollar of revenue from 2001 to 2006, now seeking an additional 12% reduction from 2006 to 2010[5]

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[2] Presentation by Steven Schultz of 3M, Achieving Superior Energy Performance Meeting March 6, 2007

[3] US Department of Energy's Energy Matters, Summer 2006 by Christopher Russell, Energy Pathfinder Management Consulting. http://www.eere.energy.gov/industry/bestpractices/energymatters/

[4] Presentation by Joseph Almaguer, Dow, Achieving Superior Energy Performance Meeting March 6, 2007

[5] US EPA Climate Leaders http://www.epa.gov/climateleaders/

The International Energy Agency (IEA) estimates that motor systems account for 15% of global final manufacturing energy use and steam systems for 38%, or nearly 46 EJ/year.[6] In the US, these motor-driven, steam, and process heating systems use approximately 17,784 TBtu of primary energy annually (including electricity losses).[7] The savings opportunities for these systems range from 10-15% for steam and process heating systems to 20% or more for motor-driven systems. This level of savings opportunities has been well-supported by field experience. The US Department of Energy (USDOE) Industrial Technologies Program estimates 7% savings potential in *total* US industrial energy use through the application of proven best practices.[8] In October 2005, USDOE initiated a program to offer an *Energy Saving Assessment* (ESA) demonstration for steam or process heating systems in 200 plants with an annual energy use of 1TBtu or higher. Eight months after completion of the assessments, 134 plants had reported almost $222 million worth of energy savings recommendations either completed, underway, or planned. Similar opportunities exist in Europe, China, and elsewhere. A program in Germany, *Druckluft Effizient*, identified average savings opportunities of 20-30% from a sample of more than 100 compressed air assessments, depending on system size (Radgen, 2003). A pilot program conducted by the United Nations Industrial Development trained 22 Chinese engineers in system optimization techniques. Within two years after completing training, these experts conducted 38 industrial plant assessments and identified nearly 40 million kWh in energy savings (Williams, et al, 2005). For the EU, the total projected investment for an extensive motor system program would be $500 million, while the annual saving would amount to $10 billion (Keulenaer, et al., 2004).

Improved energy system efficiency can contribute to an industrial facility's bottom line at the same time as improving the reliability and control of these systems. Increased production through better utilization of equipment assets is frequently a collateral benefit. Maintenance costs may decline because better matching of equipment to demand needs results in less cycling of equipment operation, thus reducing wear. Optimizing the efficiency of steam systems may result in excess steam capacity that can be used for cogeneration applications. Payback periods for system optimization projects are typically short – from a few months to three years – and involve commercially available products and accepted engineering practices.

So why haven't industrial facilities already optimized these systems for energy efficiency? Primarily due to a series of reinforcing barriers that are institutional and behavioral, rather than technical. The fundamental problems are lack of awareness of the energy efficiency opportunities by industry, consultants, and suppliers; lack of understanding on how to implement energy efficiency improvements, and, most importantly, the lack of a consistent organization structure within most industrial facilities to effectively manage energy use. Energy use is rarely measured at the system level, so there is little available data. Without performance indicators that relate energy consumption to production output, it is difficult to document improvements in system efficiency. If the facility also uses energy as a feedstock, even large system energy efficiency improvements can be lost in the "white noise" of overall plant energy usage, especially if production levels vary. Industrial energy efficiency offers large savings potentials, but is complex; a "one size fits all" approach will not work.

With the renewed interest in energy efficiency worldwide and the emergence of carbon trading and new financial instruments such as white certificates, there is a need to introduce

[6] International Energy Agency 2007. 1 Exojoule = 10^{18} Joules

[7] USDOE Industrial Technologies Program estimate based on 2002 MECS data

[8] USDOE 2006, based on results of Energy Saving Assessments conducted in 200 industrial facilities

greater transparency into the way that industrial facilities identify, develop, and document energy efficiency projects. Historically, industrial energy efficiency projects have been developed by plant engineers, frequently with assistance from consultants and/or suppliers with highly specialized technical skills. Under this scenario, implementation of energy efficiency improvements is dependent on individuals. These individuals typically include "champions" within an industrial facility or corporation, working in cooperation with consultants or suppliers who have substantial knowledge based on years of experience. This approach is not easily understood by others without this specialized technical knowledge, penetrates the market fairly slowly, and has no assurance of persistence, since champions may leave the company or be re-assigned after project completion.

What is the Framework for Achieving Superior Industrial Energy Performance?

The purpose of the Framework for Achieving Superior Energy Performance (SEP) is to promote greater energy efficiency in US manufacturing plants by making energy management as much a part of typical industrial operating practices as quality, waste reduction and inventory management. The goal is to provide a mechanism that helps each company maintain their focus on energy efficiency improvements, provide visibility for its achievements, and provide verification of results to public and private entities to "raise the bar" on industrial energy efficiency.

SEP seeks to foster energy efficiency at all levels of energy performance and a methodology for measuring and validating progress toward energy efficiency—progress that is voluntary, performance-based, and technically sound. The intent is to integrate this methodology into existing corporate management systems, such as ISO 9001:2000, 14001:2004, and Six Sigma. The long-term goals of this approach are (1) to foster an organizational culture of continuous improvement for energy efficiency, 2) to develop a transparent system to validate energy efficiency improvements and management practices and thus (3) create a verified record of energy savings with potential market value that could be recognized among sectors and countries.

In the summer and fall of 2006, several program initiatives began to converge on a central idea- to develop a voluntary framework to promote greater industrial energy efficiency that provided standardization and transparency, as well as flexibility. Such a program would be voluntary, industry-led, and based on measured performance. The concept was to build on what was already known regarding corporate energy management and system energy efficiency, and to develop an organizing framework that could eventually transition into a fee-for-service certification for energy efficiency. What is envisioned is a combination of four elements: energy management standards, system assessment protocols, certified practitioners, and measurement and validation methodologies, all under the organizing principle of certifying plants for energy efficiency. The entire framework would consist of three levels:

- ENERGY STAR for industry, which already exists and recognizes plants currently in the top 25% of their sector based on an energy performance indicator (EPI), currently available for four sectors;[9]

[9] Automobile assembly, cement, wet corn milling, and petroleum refineries currently have EPIs. EPIs are under development for food processing, pharmaceuticals, and glass, with petrochemicals planned.

- Partner Plant, which would provide plants with a flexible point of entry into a recognized, progressive program to improve energy efficiency;
- Certified Plant, which would:
    - provide a more consistent approach to industrial energy efficiency that is technically sound, yet flexible
    - integrate energy efficiency improvements into existing industrial management systems for continuous improvement, and
    - position participating plants to be recognized by the financial community for superior energy management practices and their contribution to climate change mitigation.

The organizations that initiated work on the certification concept were the U.S. Department of Energy (DOE)'s Industrial Technologies Program, Texas Industries of the Future (TX IOF), and the U.S. Environmental Protection Agency (EPA). As work on the framework progressed, the American National Standards Institute (ANSI), and the U.S. Department of Commerce's National Institute of Standards and Technology Manufacturing Extension Partnership (MEP) were brought into the discussions; in addition, a planning group consisting of industrial representatives from 3M, Dow, Dupont, Ford, Rohm & Haas, Tesoro, Toyota, and Weyerhaeuser as well as the American Council for an Energy Efficient Economy (ACEEE) was formed. This work also complemented efforts undertaken by the United Nations Industrial Development Organization (UNIDO) to promote an industrial standards framework internationally, which has as its central components energy management standards, system optimization training to develop system experts, and a systems optimization library designed to document energy efficiency improvements in an ISO-compatible format.

On March 6, 2007, the Achieving Superior Energy Performance meeting was convened by DOE, EPA, and MEP with representatives from US industry in Washington, D.C. The purpose of the meeting was exploratory--to review and help shape the preliminary program concept for recognizing and certifying industrial facilities for energy efficiency, with the working title of Framework for Achieving Superior Energy Performance in US Manufacturing Plants. This large national initiative is still in its early planning stages- the initial meeting was designed to encourage an open dialogue with representatives from the manufacturing sector, the organizing government entities, the ANSI, and a few non-governmental industrial policy experts.

While participation in this meeting was limited to industrial manufacturing companies to encourage a focused critique of the basic concepts, a website has been established at www.superiorperformance.net to encourage broader input from interested parties and future meetings that include other organizations such as suppliers, trade associations, states, utilities, and consultants are planned. Next steps include the formation of a Steering Committee and working groups to carry out further development of the framework concept.

The remainder of this paper presents the proposed Partner Plant and Certified Plant elements of the framework in greater detail and places these programs within the context of a growing international interest in energy management standards for industry.

Partner Plants

In 2003, the industries active in TX IOF asked DOE whether an energy efficiency program could be developed that was modeled after the successful US Department of Labor Office of Safety and Health Administration (OSHA) Voluntary Protection Program (VPP Star) that certifies plants for safety practices. In 2006, following the successful launch of the Save

Energy Now energy saving assessments, DOE initiated a serious dialogue on the topic. The TX companies envisioned a tiered approach that would allow industrial facilities to initiate a path to continuous improvement for energy efficiency, and that would build on existing DOE and EPA program offerings.

The concept of the Partner Plant was developed as an entry point to continuous improvement for energy efficiency that would provide any company willing to make a commitment to energy efficiency with access to technical assistance, training, and tools from DOE and EPA to assist them in:

- profiling energy use and developing a baseline of current energy intensity;
- conducting system assessments to identify opportunities for system energy efficiency improvements;
- implementing and documenting system energy efficiency improvements with near-term paybacks for "early success";
- establishing and implementing an energy management program, including
    - designating an energy manager or coordinator,
    - establishing a cross-disciplinary team empowered by the plant manager, and
    - creating a written energy management plan.

Partner plants would agree to document and report the resulting improvements in energy intensity annually. The Partner Plant proposes to build on existing program resources, such as: the DOE's Plant Energy Profiler, Energy Savings Assessments, system optimization training, system assessment software, and Qualified Specialists; EPA's Energy Management Guidelines, and the TX IOF Opportunity and Energy Reduction Calculator (for small and medium size industries).[10] Resources that have yet to be developed for Partner Plants include: a web-based "Quick Start" package on energy management, documentation and reporting tools, and a recognition program.

Certified Plants

Certifying plants for energy efficiency introduces a standardized approach to identifying, developing, documenting, and reporting on energy efficiency progress that does not currently exist. It is proposed that Certified Plants meet all of the requirements proposed for Partner Plants, with the additional introduction of standardization.

Energy Management Standard

The first building block for the certification program is an energy management standard. Georgia Institute of Technology (Georgia Tech) first developed a comprehensive ISO-compatible energy management standard for industry in 2000 that has served as a model for several subsequent national standards in Europe and China.[11] Although the standard was adopted by the ANSI, it has not received widespread use in the US due to lack of supporting program policies. A proposed activity of SEP is to engage US industry in critiquing and testing this ANSI standard with the goal of refining it for widespread use by industry.

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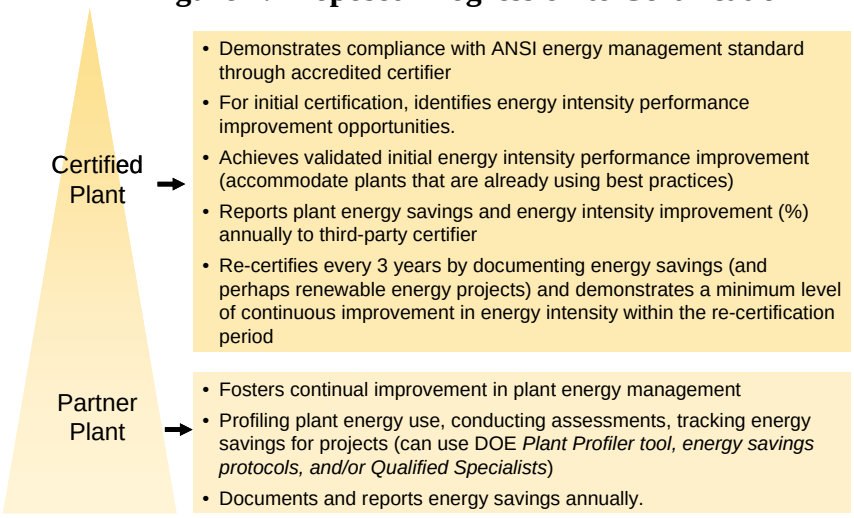
[10] USDOE--- http://www1.eere.energy.gov/industry/bestpractices/ ; TX IOF-- http://texasiof.ces.utexas.edu/ EPA— http://www.energystar.gov/index.cfm?c=guidelines.guidelines_index

[11] American National Standards Institute Management System for Energy- ANSI MSE2000:2005, see http://webstore.ansi.org/ansidocstore/find.asp?

To become certified, a plant would have to demonstrate compliance with the ANSI energy management standard through an accredited certifier. The standard will demonstrate that the plant has sustainable energy management systems in place, has completed a baseline of energy use, and has a commitment to continuous improvement of their energy intensity. It is expected that plants would re-certify themselves to the energy management standard every three years.

Figure 1: Proposed Progression to Certification



In a related action, on March 21-22, 2007, UNIDO hosted an Experts Group Meeting on Energy Efficiency and Energy Management Standards in Industry. As a result of the meeting, participants decided to move forward with:

- a request to the ISO Secretariat (at their invitation) to consider developing an international standard on energy management;
- formation of a working group of countries with existing or planned energy management standards (Denmark, Sweden, Ireland, US, China, Brazil, Korea, Spain, and the European Committee for Standardization (CEN)) to start working toward harmonization;
- a feasibility study for developing countries and transition economies to identify issues and barriers to adoption of an energy management standard by their industries, and
- information sharing on web-based energy management resources with the goal of developing focused guidance for industrial facilities that are interested in getting started on a path to continuous improvement for energy efficiency.

Due to the strong international interest, it is anticipated that significant progress will be made toward harmonization of energy management standards within two years.

System Assessment Protocols

A large body of expert knowledge exists on the most effective way to conduct assessments of industrial systems such as compressed air, fan, pump, motor/drive, process heating, and steam systems. These assessment techniques have been further refined in recent years both at the federal level (DOE's Energy Savings Assessments and Industrial Assessment Center Programs, and the Compressed Air Challenge™) and state/regional level (e.g.--Industrial

Energy Efficiency Alliance in the Pacific Northwest, Wisconsin Focus on Energy). The purpose of System Assessment Protocols is to create a market standard for industrial system assessments from the current body of expert knowledge and techniques so that use of the protocols will provide assurance to plant managers, financiers, and other non-technical decision-makers that a particular assessment represents a recognized threshold for accuracy and completeness. The existence of standardized protocols will also assist in the training of graduate engineers and others desiring a higher level of skill in the area of system optimization for energy efficiency. It is anticipated that these standardized system assessment protocols will become ANSI standards, which will ensure that a technical working group is tasked with periodic updates to maintain their applicability. The focus of the standards will be on system optimization techniques for energy efficiency, with use of software tools, such as those available through DOE, recognized as very useful for implementation purposes, but not part of the protocol per se.

Certified Practitioners

Experience in the US and other countries have shown that the appropriate application of the energy management standard and system assessment protocols will require significant training and skill. For this reason, a program to certify practitioners via a third party, such as ANSI, is planned.

For the energy management standard, an existing body of knowledge from Georgia Tech, the EPA, and countries with active programs based on an energy management standard (Denmark, Ireland, Sweden) will be used as resources to create a program for training certified practitioners in energy management. It is anticipated that these practitioners will be either plant personnel or consulting professionals with management or technical experience in industry.

A program to certify practitioners in system energy efficiency can be built on a foundation that includes the DOE Qualified Specialist and ESA Expert initiatives, as well as a large network of system assessment professionals active in the Compressed Air Challenge™, Steam Best Practices, and the Process Heating Steering Committee. As with energy management, it is anticipated that these practitioners will be plant personnel or consulting professionals with the appropriate technical experience in industrial systems who are subject to a rigorous qualification exam and periodic professional enrichment requirements. Over time, DOE expects to transition from the Qualified Specialist and ESA Experts to this new initiative of Certified Practitioners.

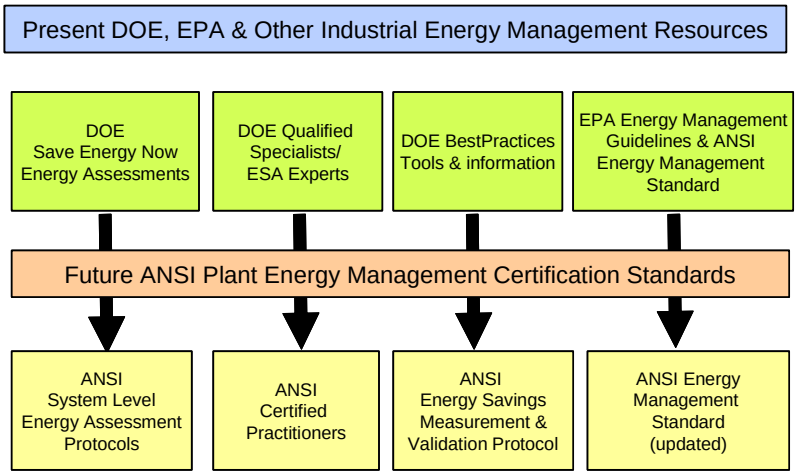
Monitoring and Verification

An essential element of certifying plants for energy efficiency is validating plant performance through monitoring and verification (M&V). A separate class of experts are required for this activity—individuals and organizations who can maintain independence during the verification process. The M&V process to certify plants for energy efficiency is challenging due to the need to balance assurance of performance with the M&V cost to the industrial facility. Inadequate M&V will compromise the value of the reported energy savings and reduce the potential to link reported values to state-level emissions trading schemes and other initiatives that value carbon emission reductions. On the other hand, if M&V requirements become too costly or onerous for industrial facilities, industry will simply opt out of participating in the certification program.

To develop the M&V strategy, use of the following resources is anticipated: the International Performance Monitoring and Verification Protocol (IPMVP), nationally recognized

experts in M&V techniques for utility energy efficiency programs, and the structure of the ISO 9000/14000 auditor certification program.

Figure 2: Building on Existing Resources



Outcomes of First SEP Industry Meeting

The first meeting of industrial representatives on March 6, 2007 to critique the SEP program, resulted in a substantial amount of input, which is summarized below:

- Participants expressed both a strong interest and a need for a voluntary program to assist all US manufacturing plants in improving energy efficiency, regardless of size or internal resources;
- Existing information and tools are useful, but more needs to be done to provide and streamline access to this information so that plants can save energy in the near-term;
- Many plants need assistance in developing and implementing energy management plans, especially if the program is pushed up the supply chain;
- Attendees perceived a value in the certification of an industrial facility's energy management program that produces sustainable results and ensures the engagement of all levels of plant personnel;
- Any plant certification would address the measurement and verification of savings by the facility being certified;
- Individual energy efficiency projects could have energy savings validated, and therefore, could potentially provide tradable benefits.
- Any program to certify plants for energy efficiency has to "make the business case" for participation;
- Certification requirements should achieve a balance between documenting performance and the cost, in both time and money, of doing so, and
- Financial incentives, such as- a tax credits, loan guarantees, would help to level the playing field for access to capital needed for implementing energy efficiency projects and increase program attractiveness for "early adopters".

Participants in the meeting were invited to identify their interest in becoming involved in planning the Partner Plant and Certified Plant initiative. Sixteen companies participating in the initial meeting were sufficiently interested to volunteer to serve on a steering committee for

program development. TX IOF is planning a pilot program in 2007-2008 to determine informational needs, and to test performance criteria and assessment methodologies by working with five Texas plants.

Conclusion

More than a decade of industrial energy efficiency program activities has clearly demonstrated that substantial opportunities continue to exist to improve energy efficiency in US industry. With more than one-third of all US energy used by industry, this sector is gaining increased attention as a potential source of greenhouse gas (GHG) emissions mitigation. It is clear that US industries would like to address climate change in ways that are consistent and supportive of good business practice. Due to the variations in production volume and types over time, energy management is needed to create sustainable energy efficiency in industry. The proposed Framework for Achieving Superior Energy Performance creates a platform for standardizing industry's approach to sustainable energy efficiency that builds on the most effective program information and activities developed in the US to date. By engaging industry to lead development of a certification program for energy efficiency, the activity's organizing agencies, USDOE, EPA, and MEP, seek to create a program with private sector roots that the public sector supports, but does not own. Essential to program success will be striking a balance between a flexible and streamlined approach on one side and accountability and transparency on the other.

Since many US manufacturers have global operations or a global supply chain, the recent international interest in developing a common international energy management standard contributes very positively to the SEP. Five years from now, it is hoped that plant certification will be a well-accepted method for recognizing effective energy management in an industrial facility and for verifying energy savings from energy efficiency improvements in industrial facilities and their suppliers.

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